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ABSTRACT

Alaska oil and gas regulatory matters are under the jurisdiction of a three-man Oil and Gas Conservation Committee, all of which are state employees.

In the last 10 years State water bottoms in Cook Inlet have been leased, explored and oil production amounting to about 200,000 barrels a day has been established. Cook Inlet is subject to very high tides and heavy ice flows. Five Salmon runs also occur in the Cook Inlet. The average daily production rate per well in the Cook Inlet area is nearly one hundred times the national average.

The Prudhoe Bay oil field discovered in 1968 is the largest oil field in North America. It lies entirely on State land. After public hearing, the Committee prescribed 640-acre spacing for two of the thicker reservoirs and detailed many safety and operational requirements. The orders prohibited the flaring of gas except for operational necessities. Over 40 wells have now been completed in this field but a pipeline has not been approved.

The State of Alaska looks forward to the challenge of proper development of a resource valuable to the State and the Nation.

INTRODUCTION

In Alaska, oil and gas regulatory matters come under the jurisdiction of the Alaska Oil and Gas Conservation Committee. This Committee differs dramatically from oil and gas regulatory bodies in the other 33 oil producing states in several aspects. The Committee is composed of the Director of the Division of Oil and Gas, the Chief Petroleum Engineer and the Chief Petroleum Geologist assisted by the entire technical staff of the Division, all of which are state employees working within the framework of the Division of Oil and Gas of the Department of Natural Resources. The Committee does not contain any citizen members such as do most all of the conservation agencies in the other states. The reason for this absence of citizen members who are unaffiliated with the state government is, in part, based on a very different land ownership situation than is found elsewhere, namely that the amount of state-owned lands in known petroleum producing basins is many, many times that of any other state.

All oil production in the State of Alaska at this time is on state or federal lands. This comes about from the fact that Congress, through the Submerged Lands Act of 1953 and confirmed by the Alaska Statehood Act of 1959, granted the State of Alaska offshore lands to the three-mile limits, and to the seaward limits of inland waters. The Supreme Court, through a subsequent California tidelands decision, granted title to sea bottoms which are within a 24-mile closing line between headlands. These actions, in part, resulted in the State of Alaska obtaining title to all of the upper Cook Inlet area water bottoms and the upper portion of the lower Cook Inlet to a point just south of Kalgin Island. All of Alaska's offshore production comes from the upper Cook Inlet area.

By authority vested in the state by the Alaska Statehood Act, the State of Alaska was granted the right to select about 103,000,000 upland acres of land from the federal public domain. Using this selection authority, the state in the early sixties selected almost all of the onshore Cook Inlet sedimentary province, parts of the shorelands bordering the Gulf of Alaska, part of the Copper River Basin; and, in the mid-sixties, selected that portion of the Arctic Slope on which the Prudhoe Bay Field was later discovered in 1968. To facilitate management, these selections are in large solid blocks, not in widely spaced checkerboard patterns as is the case in most western public land states.

Alaska still has the authority to select approximately 75 million acres and it can reasonably be assumed that the state will act to obtain title to other lands considered to have a significant petroleum potential before the expiration of selection authority in 1983. The size of the state's mineral land inventory will not shrink as lands are conveyed to private ownership because the state retains all mineral rights and deeds only the surface rights. As you may be aware, there has been a Federal Government freeze on selection of land by the state, and on entry of public lands by anyone, for that matter, pending settlement of the Alaska Native Land Claims.

The Oil and Gas Conservation Committee administers the drilling and production activities of the oil industry through regulations which were formulated by very close cooperation with the Interstate Oil Compact Commission as to basic

form; and, what is more important, have been revised completely after many public hearings to make them adaptable to Alaska's very unique environmental and operational situations; for instance, the first production on state lands in Alaska came from the waters of Cook Inlet which are swept four times a day by tides ranging up to 33 feet between extremes. In addition, in the wintertime these waters contain floes of ice many times the size of this auditorium which move at rates up to six knots and are cut by the legs of the platforms which are standing in up to 150 feet of water. Five salmon runs also occur each summer in Upper Cook Inlet.

Since drilling and producing platforms cost upwards of 20 million dollars apiece, operational space on them is at a very great premium, and it is an economic necessity to limit the number of platforms and develop the fields by directional drilling methods.

Offshore discoveries were made from anchored floating drilling vessels but development drilling and production operations are handled from 14 permanent platforms fastened to the sea floor (Figure 1).

Construction, personal safety, drilling and production problems inherent in such an operation required new methods and oil and gas regulations to match. Cooperation between government and industry accomplished this. In the process, the Alaska Oil and Gas Conservation Committee gained some experience in adapting regulations to unique environmental and operational conditions. We hope this experience can be used constructively in an Arctic Slope oil province.

GENERAL STATE RULES

There are many distinctive features to the current Oil and Gas Conservation Regulations. For example, oil well spacing is set at 160 acres per well. To those oil producing states where five and ten acre well spacing is common Alaska's 160 acre statewide well spacing may appear excessively large. However, the national average individual well production rate is 12 barrels of oil per day and the current Alaska average is over 1,180 barrels of oil per day, very close to one hundred times the national average. The eventual production from shut-in wells in the Prudhoe Bay Field is not included in these figures. After discovery of oil the Committee may reduce or enlarge the spacing acreage after public hearings. In the case of the shallow, highly faulted Trading Bay Field in Cook Inlet waters, spacing acreage has been reduced to 40 acres per well, and in the Prudhoe Bay Field the Sadlerochit Pool spacing has been increased to 640 acres per well. The Sadlerochit reservoir is approximately 600 feet thick and production tests indicate sustained rates may be in the range of 15-25,000 barrels of oil per day.

The West Coast of the United States would be able to take all of Cook Inlet's current 223,000 barrels of oil per day oil production, therefore market proration is not necessary. The Oil and Gas Conservation Regulations do provide for restriction of total production from a pool and an equitable distribution among the wells in that pool, if necessary, in order to prevent waste or to protect correlative rights. At present, most reservoirs in Cook Inlet fields are considered to have a solution gas drive and are probably not rate sensitive.

Correlative rights problems have been comparatively few because of the rather low number of well operators and the relatively high number of field-wide utilization agreements in effect.

The Committee has approved secondary recovery projects utilizing filtered Cook Inlet sea water for all offshore Cook Inlet fields, thereby increasing ultimate recovery to an estimated 35-40% of the total oil in place as opposed to a 14-18% recovery without additional recovery methods. A very successful gas injection project is in effect in the Swanson River Field which is the only onshore oil field in the Cook Inlet area.

Our Committee requires the submission of all well logs and other significant well data. This information is kept confidential by the Committee for two years after the well is completed, suspended or abandoned.

REGULATORY ACTIVITY

Having touched on some generalities of our statewide rules, let us now zero in on the regulatory activity in Alaska's Arctic. Active Conservation Committee involvement in the Arctic began in the mid-sixties when a dozen unsuccessful exploratory wells were drilled on Federal lands east of the Naval Petroleum Reserve #4 and about 200 miles southwest of the Prudhoe Bay area. Our State regulations also apply to all wells drilled on federal lands within the territorial limits of the state.

The Prudhoe Bay Field discovery was announced in 1968 by the Atlantic Richfield Company and the Humble Oil and Refining Company. This field lies on state selected lands on the coast of the Beaufort Sea, a part of the Arctic Ocean lying east of Point Barrow, Alaska, the northernmost point of land in Alaska (Figure 2).

In September of 1969, in the largest lease sale in United States history, the State of Alaska received over $900,000,000 in bonuses for 450,000 acres of miscellaneous tracts not previous-

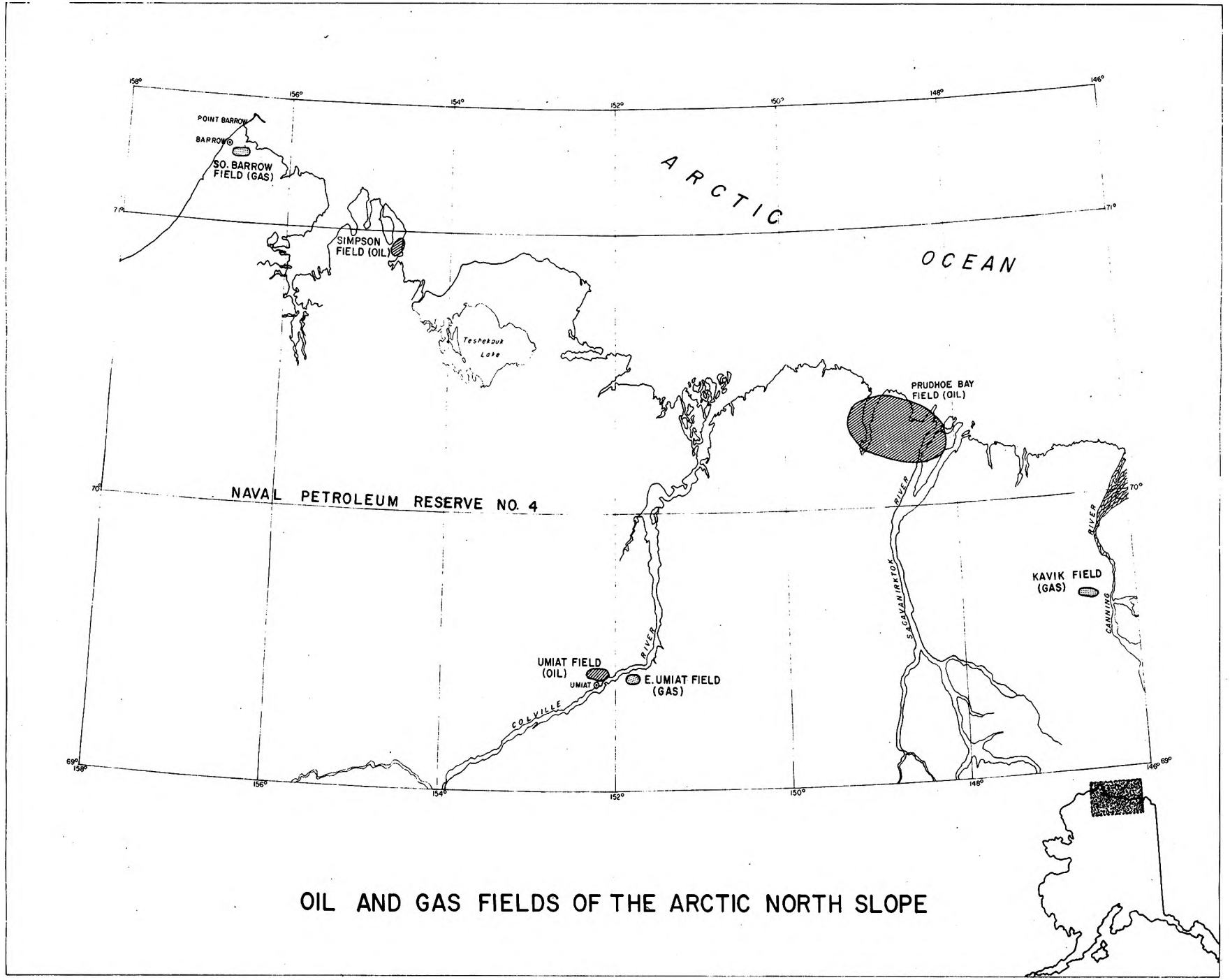

Figure 1. Oil and gas fields of the Arctic North Slope.

ly leased when the main portion of the field as presently known was leased before the Prudhoe Bay discovery was made. Before the lease sale and before the pool rules were written the Committee held a public hearing and issued an order granting an exception to the statewide rules to permit the use of slip joint casing which was not cemented completely from the casing shoe to ground surface as the statewide rules prescribe. Theoretical studies indicated that subsidence from thawing would occur and the drag of the subsiding material could cause failure of a conventionally cased and cemented well. Specially designed slip joints in the permafrost casing string and special well heads may enable that string to withstand the forces of subsidence and allow this special casing to move relative to the surface casing permitting the surface casing to carry the load of the inner casing and tubing strings.

Under ordinary conditions the Alaska Oil and Gas Conservation Committee holds a pool rules hearing shortly after the discovery of oil or gas to establish pool limits and consider well spacing, casing and cementing requirements and other regulatory matters. However, in the case of Prudhoe Bay the secrecy of the geological information gained from drilling on existing state leases was so important that the Committee deferred the pool rules hearing until after the sale. Our regulations require that pool rules must be made from public testimony and not from information the committee may have received otherwise. Fortunately, most operators in the prolific Sadlerochit pool saw the merits of wide spacing and proceeded with unofficial 640 acre spacing until the pool rules hearing was held and the order executed in January 1970. The field order was 18 pages in length and was broken down into three separate parts, one for each of the three pools which the Committee defined. Some of the highlights are as follows:

The three pools which the Committee defined are: (1) the Prudhoe Bay Kuparuk River Oil Pool, which occurs at comparatively shallow depths in Cretaceous rocks in the northwestern area of the field; (2) the Prudhoe Bay Sadlerochit Oil Pool, the major reservoir in the field, which is mainly of Permo-Triassic age lying at a depth of approximately 8,500 feet, and (3) the Prudhoe Bay Lisburne Oil Pool, a thick, carbonate rock reservoir which lies under the Sadlerochit Formation in the easterly portion of the Prudhoe Bay Field and is mainly Mississippian and Pennsylvanian in age. The Lisburne pool limits are quite speculative at this time.

One rule sets out the vertical and areal extent of each of the pools and another prescribes 640-acre spacing for the Lisburne and Sadlerochit pools and 160-acre spacing for the Kuparuk River Pool. Some operators had requested 640-acre spacing for all pools in the Prudhoe Bay Field; however, the Committee did not find sufficient evidence in the testimony to support such a rule and issued a rule in support of 160-acre spacing for the relatively thin and lenticular sands of the Kuparuk River Sand Pool. The Committee also set minimum distances of wells from lease boundaries where ownership changes and minimum distances between wells in order to ensure proper drainage of the reservoirs in each pool.

A four-paragraph rule on casing and cementing requires that wells be protected from damage caused by permafrost thawing by the use of refrigeration or insulation, or by the use of slip-joint casing.

Another rule which applies to all three pools requires three remotely controlled blowout prevention devices on drilling wells plus various other emergency valves. Stringent operating and testing requirements were specified for this equipment. Each completed well is required to be equipped with a fail-safe subsurface valve which will automatically shut in the well in the event of an uncontrolled flow. Bottom hole pressure surveys and gas-oil ratio tests will be required at regular intervals in order to enable the Division of Oil and Gas to monitor the reservoir performance in the field.

The orders that evolved contain a rule prohibiting the flaring of gas, except as may be authorized in cases of emergency or operational necessity. The Prudhoe Bay Sadlerochit and Lisburne reservoirs, unlike Cook Inlet reservoirs, have associated gas caps and the Committee intends to require this gas be used, sold, or reinjected into the reservoir.

The first exception to the Prudhoe Bay pool rules was granted on February 20, 1970, a little over a month after the rules were written, wherein the Committee allowed the completion of a well in the Sadlerochit pool in a section of land containing less than 600 acres after the finding was made that correlative rights would not be adversely affected. Pool rules prescribed the spacing unit in this pool as a governmental section, but due to the marked convergence of the lines of longitude in the northern latitudes and the resultant adjustment in the legal survey grid, all the westerly tier of sections in each township in the field contain less than 600 acres.

The next request for an exception to the Prudhoe Bay Field rules resulted in an order concerning the operation of the crude oil topping plant operated by Atlantic Richfield Company in the Prudhoe Bay Field which had been producing about 1000 barrels of Arctic diesel fuel per day

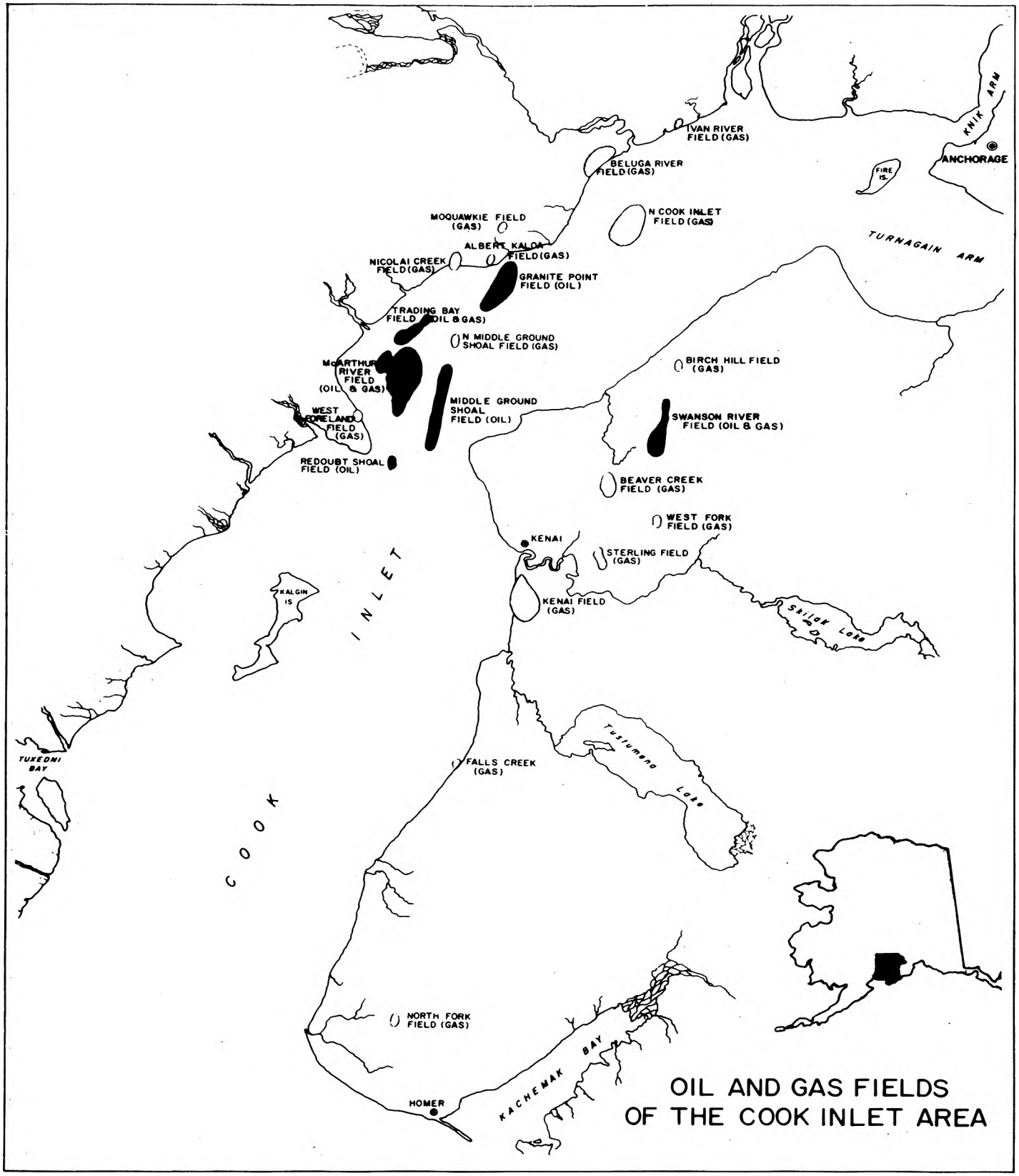

Figure 2. Oil and gas fields of the Cook Inlet Area, Alaska.

from a 5000 BOPD crude throughput. The 4000 BOPD of unused fractions were injected into the producing formation, the Sadlerochit sandstone.

The committee had permitted the flaring of casinghead gas in excess of the amount used for topping plant fuel and for other beneficial camp purposes for a limited time as an operational necessity. The Committee was concerned that possible reservoir damage may result from the injection of the lower API gravity fractions and questioned the continued necessity to flare casinghead gas.

The Committee order reduced the plant input to 2750 BOPD, thereby virtually eliminating flaring of casinghead gas not beneficially used. The Committee concluded that ultimate recovery was not adversely affected by injection of unused fractions.

A recent request for exception dealt with the location of a well closer than the allowed limits to a lease line. In view of the imminence of a unitization agreement in the Prudhoe Bay Field, no opposition is expected to the issuance of an approving order.

IMPORTANCE OF THE PRUDHOE BAY FIELD

How important is the Prudhoe Bay Field? Fortunately, the oil reserves are large enough to offset transportation costs to markets. Our strict confidentiality statute does not permit us to release any of our own reservoir data based on well information less than two years old and only the discovery well is now over that two year mark. However, using some published estimates and a few rule of thumb factors we can approximate the size of this field. A total of 62 wells have now been drilled within the field limits and industry sources estimate the primary reserves of just the Prudhoe Bay Field at between 12-15 billion barrels of oil which, if correct, would make it the second largest oil field in the Western Hemisphere, the largest being the Bolivar Coastal Field in Venezuela. Solution gas reserves have been published as 10 trillion cubic feet, but let me emphasize that this figure represents only the amount of gas in solution in the estimated primary oil reserves of the present oil-gas ratio. Recoveries of upwards of 20 trillion cu. ft. are more realistic under the actual producing situation expected.

In addition to solution gas, a large associated gas cap exists in the Sadlerochit reservoir. An associated gas cap also exists in the Lisburne reservoir, but its size is undetermined at this time because of the dearth of subsurface data.

Gas reserves are large enough to be of interest to marketers in the Lower 48 states. This may ease the burden of handling the field's casinghead gas reserves which may not be flared under the pool rules.

Full scale production from Alaska's Arctic must await completion of transportation facilities which because of the size of the proposed project will be several years in construction after the necessary approvals are obtained. The Department of the Interior has not yet given the TAPS pipeline permission to construct the line across Federal lands and several legal barriers also exist. At this time 39 wells could be rendered capable of producing about 650,000 BOPD from the Prudhoe Bay Field. When the pipeline is completed it will probably go on stream with a throughput of over 1,000,000 BOPD. At the present rate of drilling this initial capacity will be achieved well in advance of pipeline completion.

Although it is definitely not true that all Alaskans live in igloos swept by chilling winds, still the reality of a tremendous energy source in the midst of our coldest region brings hope of a better way of life. In a land where some people must haul driftwood or ledge coal for many miles to heat their homes, the development of a lower cost fuel source is indeed a warming thought.

The State of Alaska has an unusual responsibility and opportunity to guide the development of a tremendous oil resource. It is our fervent desire to do the job well.

Thomas R. Marshall, Jr.

Mr. Marshall was born in Loupe City, Nebraska, attended Westminister College in Fulton, Missouri, and graduated from the University of Colorado, Boulder, Colorado, in 1950.

He worked as a pumper, scout, scout leaseman and geologist for the Texas Company, Casper, Wyoming, and as a geologist for Brinkerhoff Drilling Company, Casper, Wyoming until 1955.

As a consulting geologist in Casper, he was active in both uranium, non-metallic and oil and gas exploration. He moved his family to Anchorage, Alaska, in 1958 at the start of oil exploration in Alaska's Cook Inlet area. In 1959 he filed on a Federal homestead near Wasilla, Alaska, and lived there for two years.

He joined the Department of Natural Resources of the State of Alaska in 1960 as the land selection officer. He was responsible for the geological recommendations to select for the State, under the Alaska Statehood Act, the area on which the Prudhoe Bay and Ugnu Oil Fields were later discovered. Subsequently, he worked as Petroleum Geologist and Petroleum Supervisor in the Division of Mines and Minerals; and his present position is Chief Petroleum Geologist for the State Division of Oil and Gas, and executive Secretary of the Alaska Oil and Gas Conservation Committee.